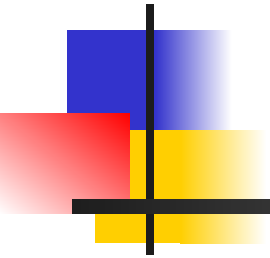
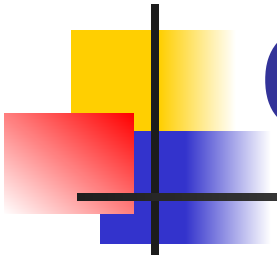
GlueX collaboration meeting, Newport News, Oct. 2-4, 2014



Simulation of background in the Hall D tagger area

Richard Jones
University of Connecticut



Outline

- review of electron beam model (CASA, 2006)
- review of results from earlier simulations (Somov, 2011)
- updates to the geometry
- simulation parameters
- new results
- comparison with earlier results
- effectiveness of TAGM shielding solution
- remaining issues for study

review: 12GeV e^- beam model

- CASA published a study using a ray-tracing simulation of electrons in the 12 GeV machine, based on 6 GeV data.

JLAB-TN-06-048

Studies of Beam Halo Formation in the 12 GeV CEBAF Design

Yves Roblin and Arne Freyberger*

Beam halo formation in the 12 GeV beam transport design is investigated using beam transport models and data from 6 GeV operations. Beam halo due to beam gas scattering is shown to be less of a problem at the proposed higher energies than at 6 GeV. Beam halo due to non-linear effects of magnetic elements is characterized as a function of the beam orbit. For a beam orbit that is confined to less then ± 1 mm transverse of the nominal magnet center, the ratio beam halo to the beam core is less then 2.9×10^{-5}, where beam halo is defined as beam particles with at least ± 5 mm displacement from the beam center. The amount of beam halo as a function of the RMS beam orbit is presented.

Functional forms of the halo distribution are presented, these functional forms can be used to generate halo in subsequent studies and for detector optimization.

GlueX halo sensitivity

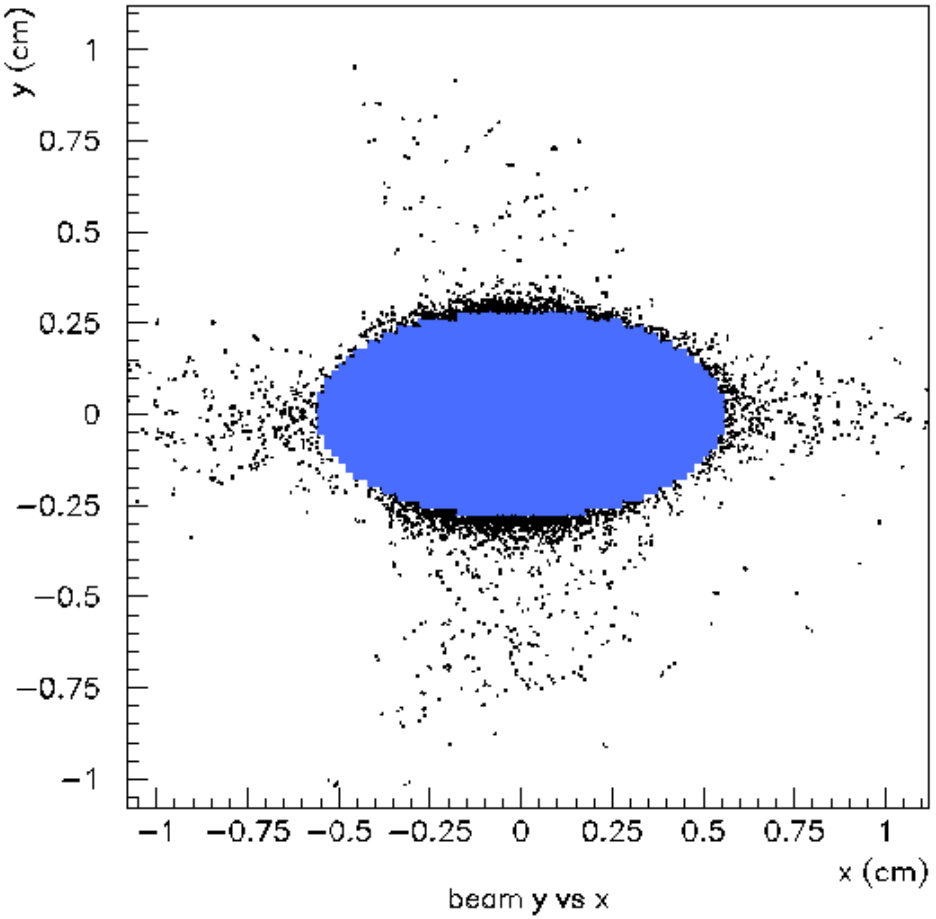
- Original estimate (July, 2006) was based on some brutal assumptions regarding the shape of the halo.
  1. uniformly distributed out to r = 25 mm
  2. same energy, direction distribution as core beam

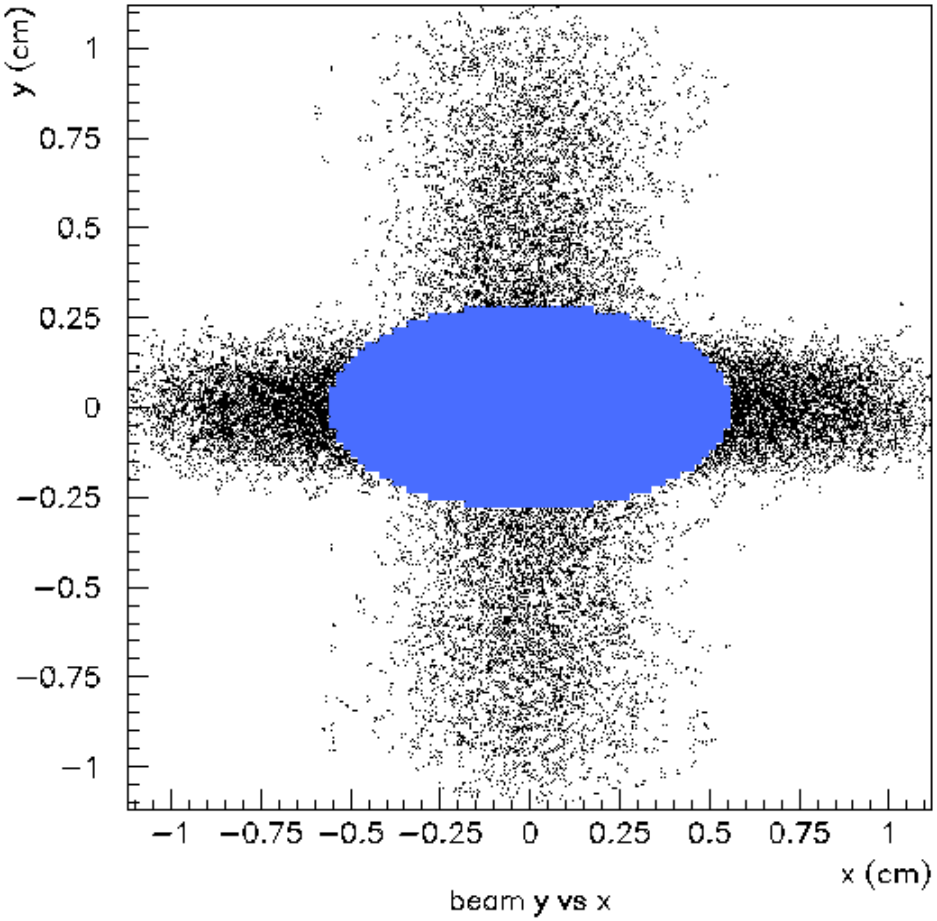
- Criterion was halo-related backgrounds in the tagging counters should contribute <1% to their rates.

- Result: 10^{-5} beyond the $5-\sigma$ ellipse

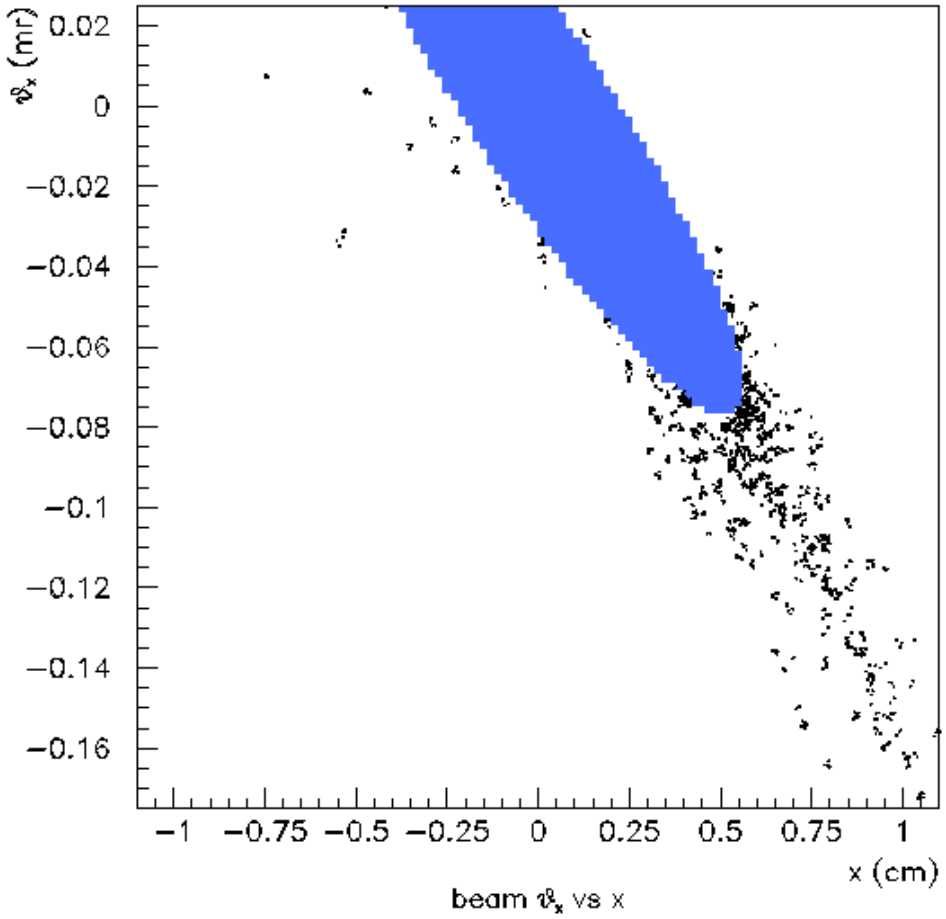
- CASA estimate: $3 \cdot 10^{-5}$ beyond r = 5 mm boundary.

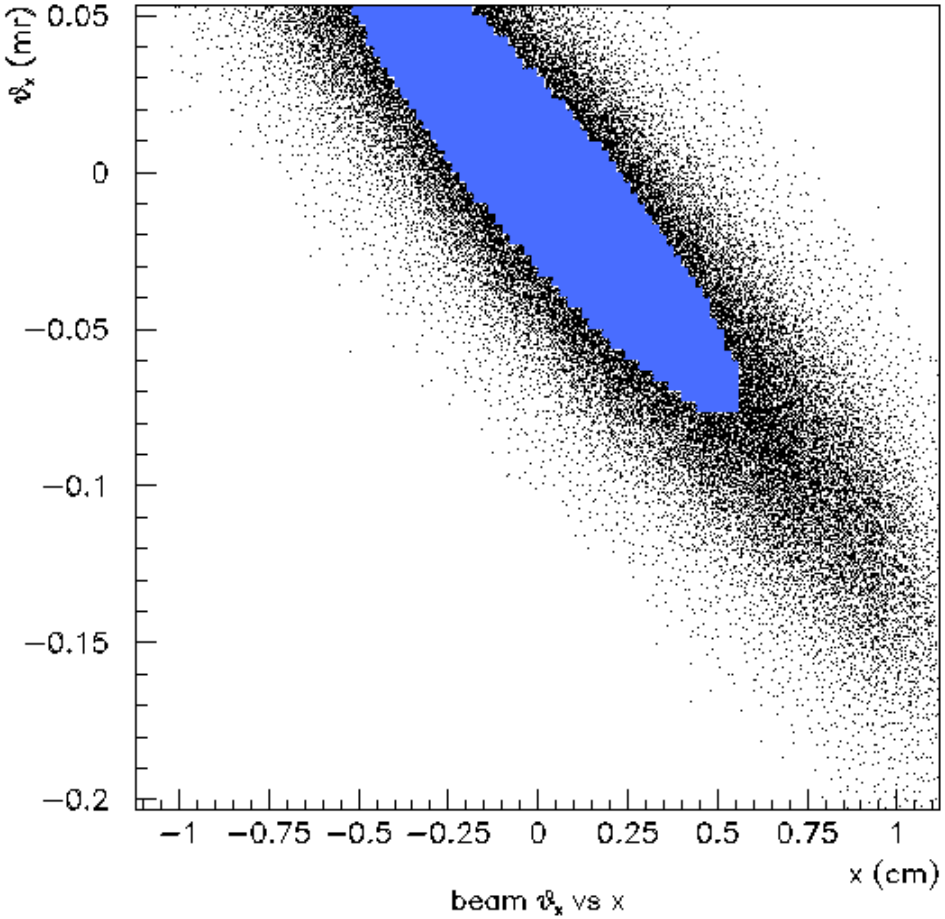
GlueX "gxtwist" simulation:
e^- beam model based on TN-06-048



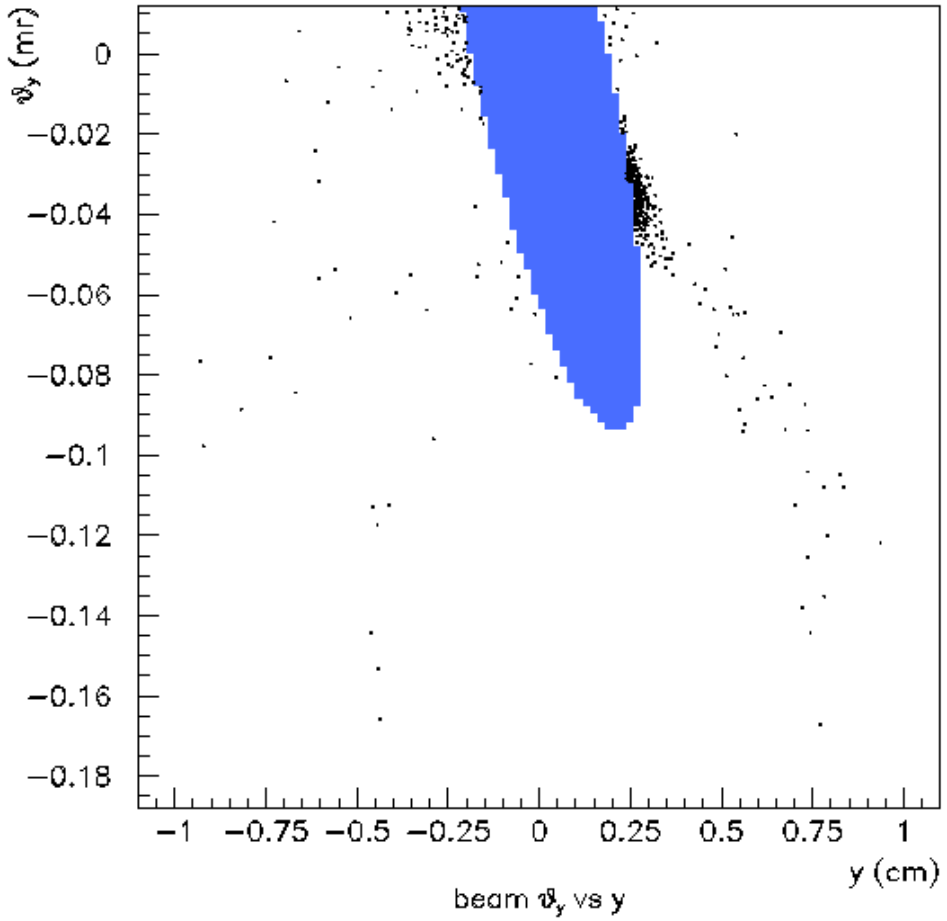


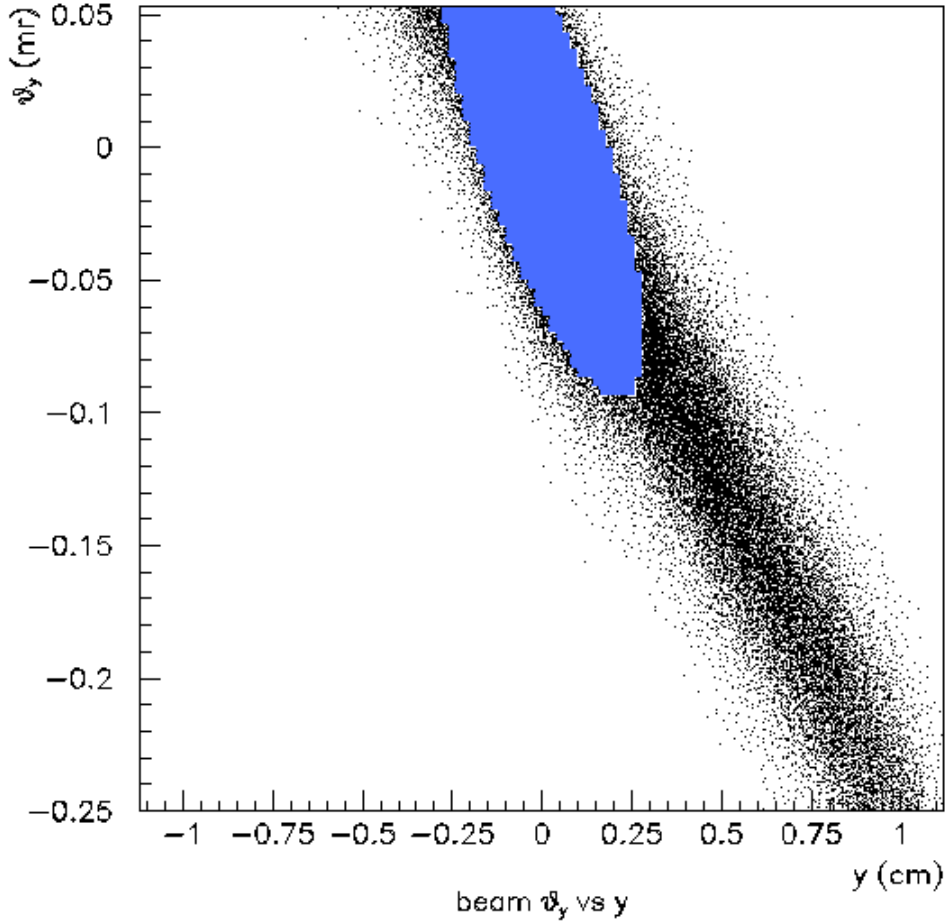
GlueX "gxtwist" simulation:
e^- beam model based on TN-06-048



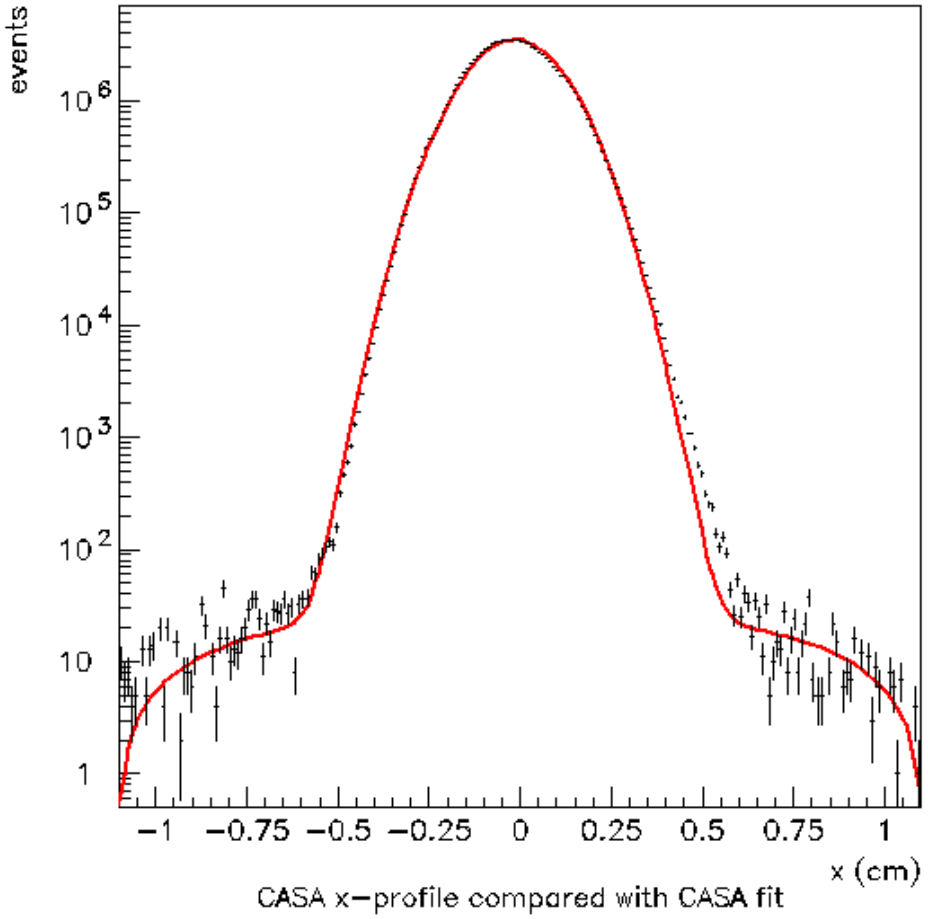


GlueX "gxtwist" simulation:
e^- beam model based on TN-06-048

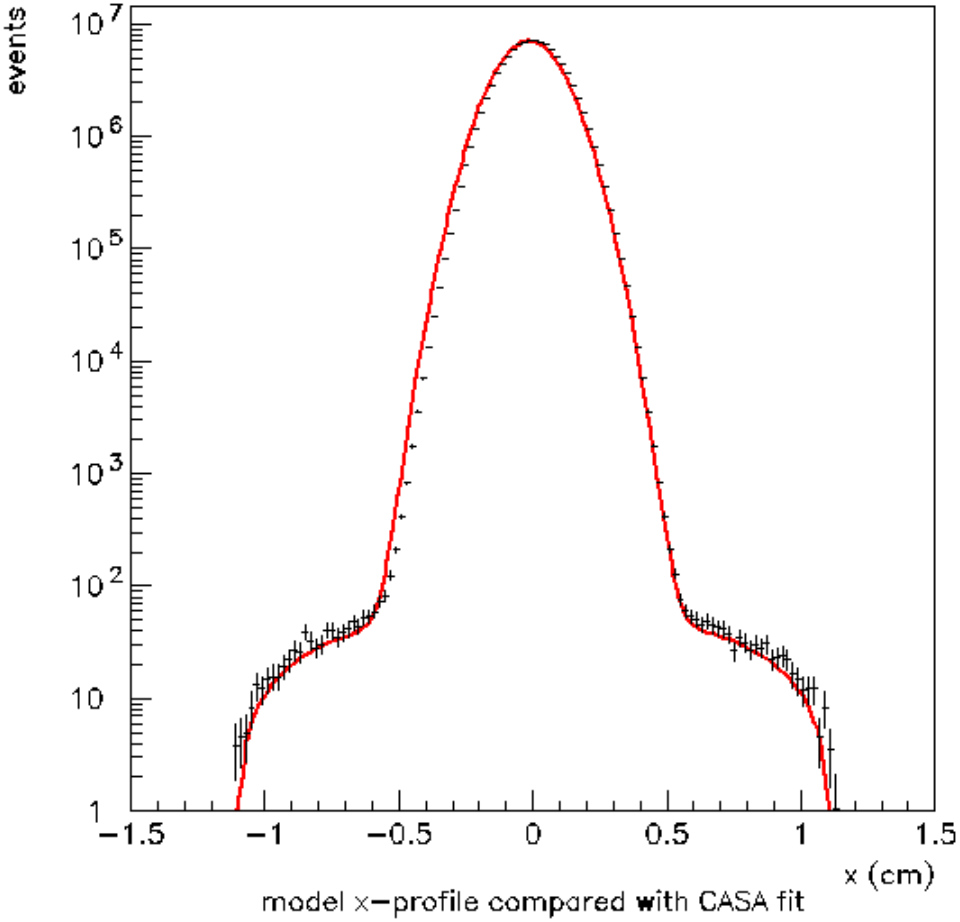




Comparison in projections

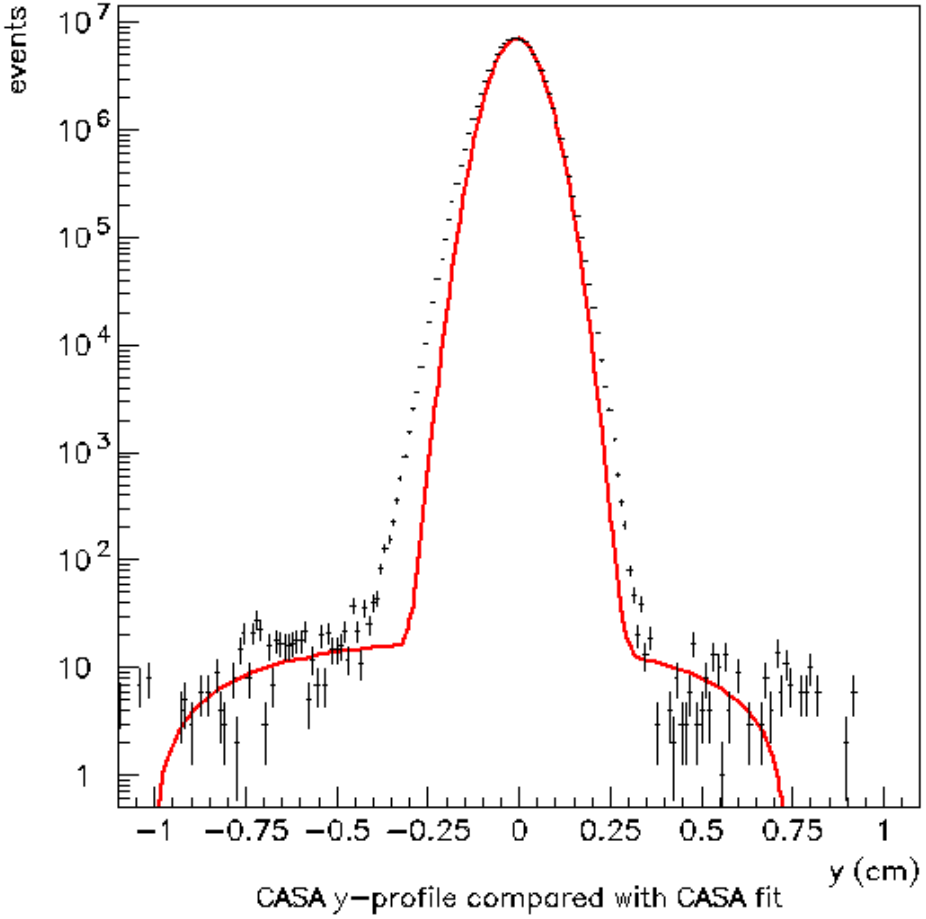


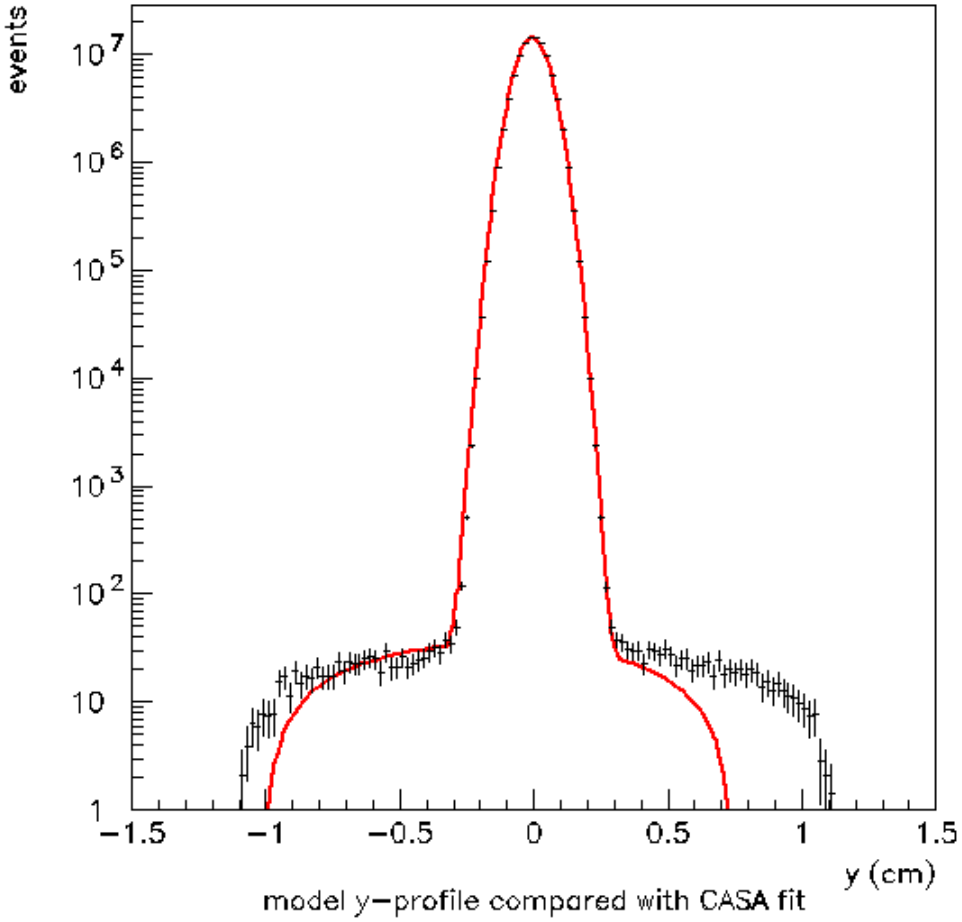
CASA x−profile compared with CASA fit



model x−profile compared with CASA fit

Comparison in projections





review: first gxtwist results

GlueX-doc-1646
Version 0.2
February 24, 2011

Neutron background estimates in the tagger hall

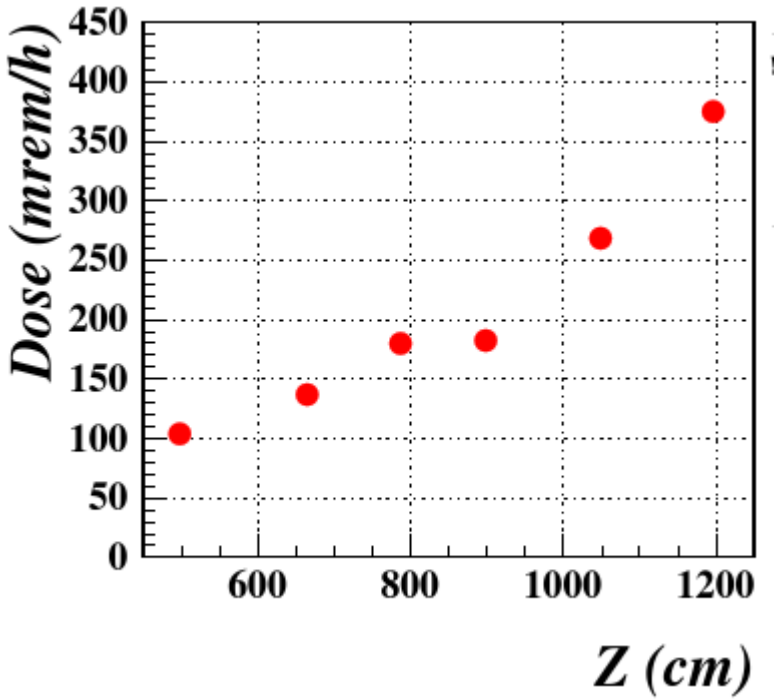
A. Somov, *JLAB.*

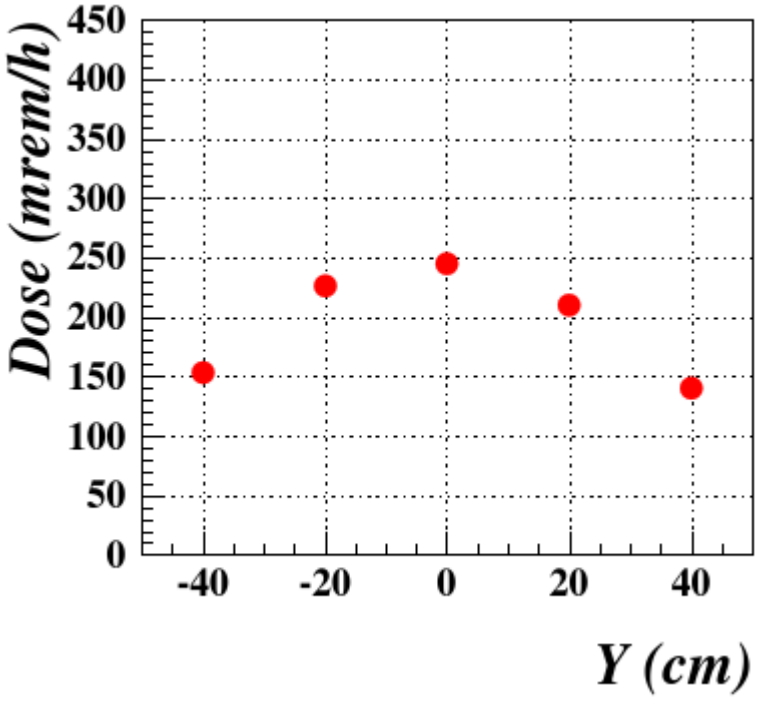
Abstract

This note describes the simulation of the neutron background in the microscope detector region of the tagger hall. The background was estimated for various layouts of the vacuum chamber and sizes of the electron beam pipe.

review: first gxtwist results

- showed that neutron dose IS a concern for electronics, especially the SiPMs
- 50 rems => dark rate increase factor ~5 over baseline rate ~1MHz
- assume dark rate increases linearly with dose: ~10 MHz / 100 rems
- **TAGM dark rate deemed significant at 1 GHz => unshielded lifetime 40khr**





updates to the hall geometry

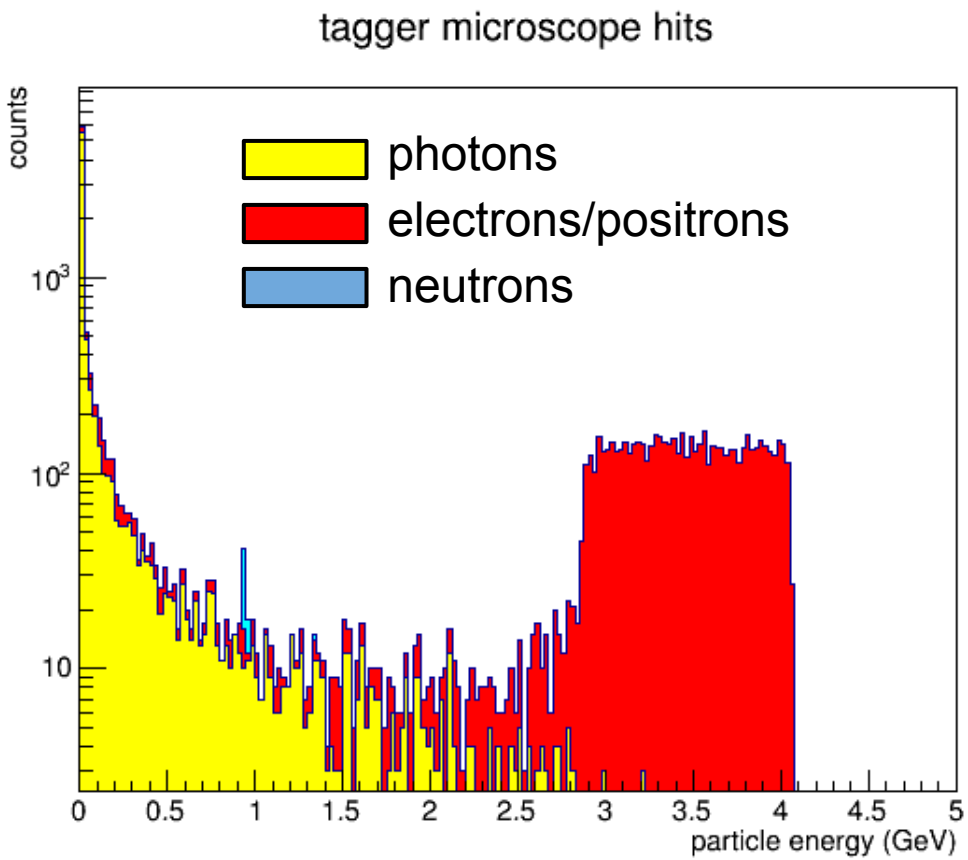
- ★ original simulation considered several options for e^- beam tube
- ★ recommended choice had exit 6” e^- beam tube
  - starting from tagger vacuum chamber exit flange
  - punching through the dump labyrinth walls
  - all the way through labyrinth wall 3
  - air between labyrinth wall and dump
  - **simulation stopped before air gap -- beam dump was not simulated**
- ★ **as-built geometry is somewhat different**
  - 6” pipe necks down to 1.5” pipe before the first labyrinth wall
  - girder with accelerator instrumentation is installed past first wall
  - gaps are incompletely filled where the pipes punch through the walls
  - labyrinth walls don’t extend all the way to the ceiling
  - actual TAGM readout shielding is more hermetic
  - … many other less important details in the shielding arrangement

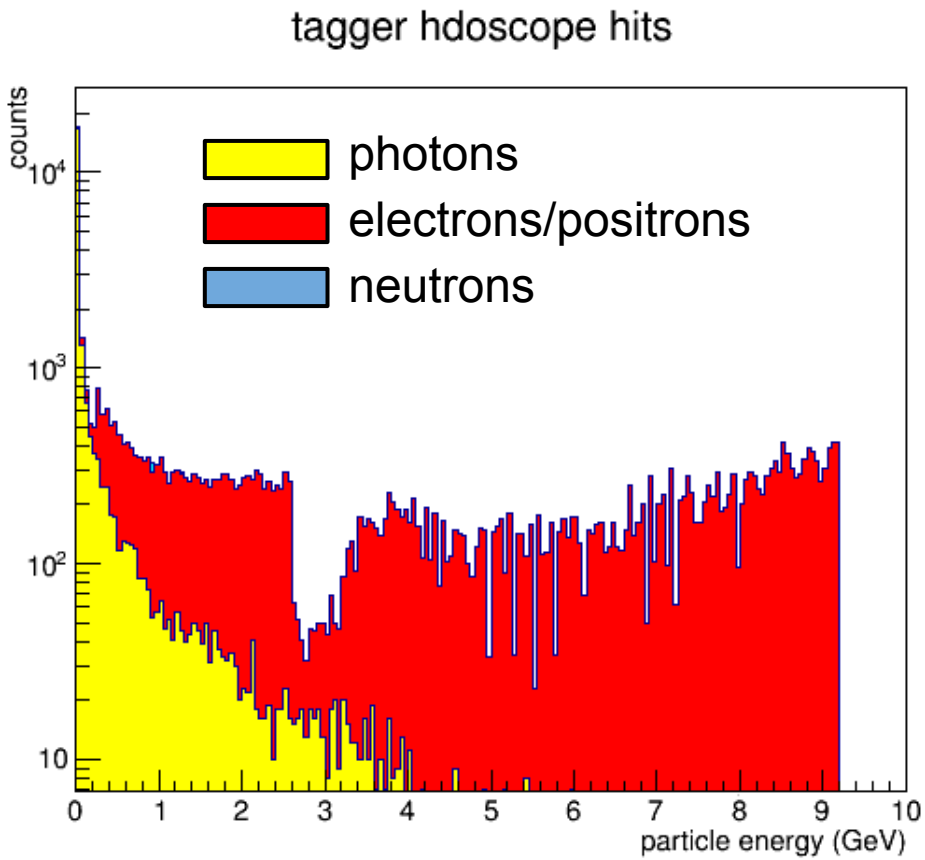
new simulation results

- emphasis on commissioning-phase conditions
  - exaggerated e- halo: **10^{-2} of total e- beam**
  - special interest in neutrons: **tracked down to 10keV**
  - complete simulation: **including full beam dump int.**
  - only amorphous radiator: **10 microns of graphite**
  - using latest TOSCA field map
- normalized to full luminosity conditions for GlueX
  - 250 MHz total rate in range 8.4 - 9.0 GeV (12 GeV e^-)
  - 10^9 beam electrons simulated (300,000 core-hr on OSG)
  - 5000 hits seen in TAGM: **10μs @ 16μA (!)**

new simulation results

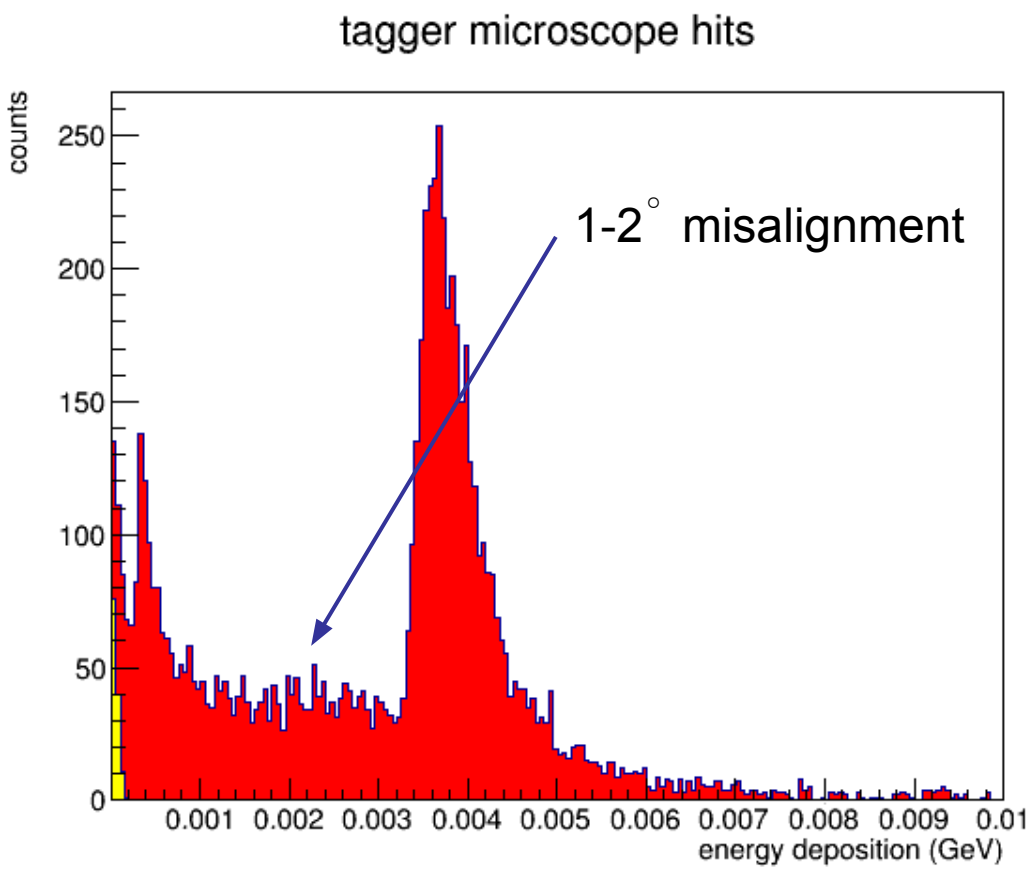
energy of particles reaching the tagging counters

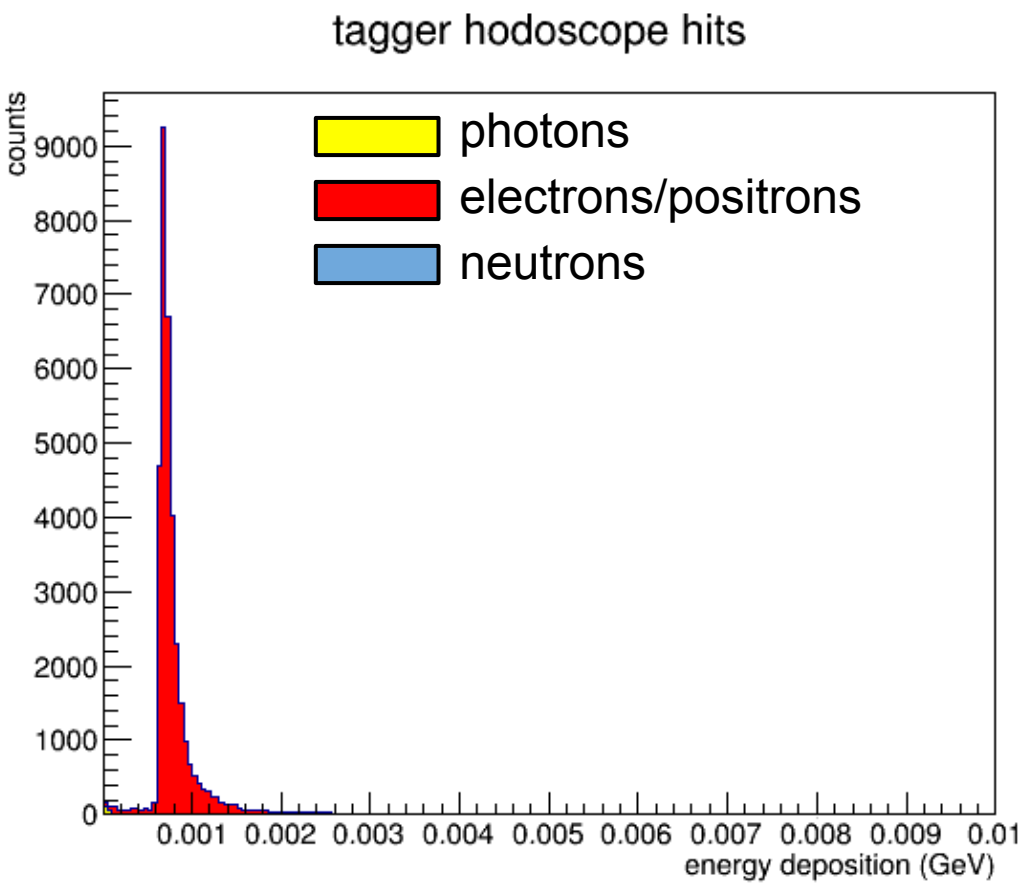




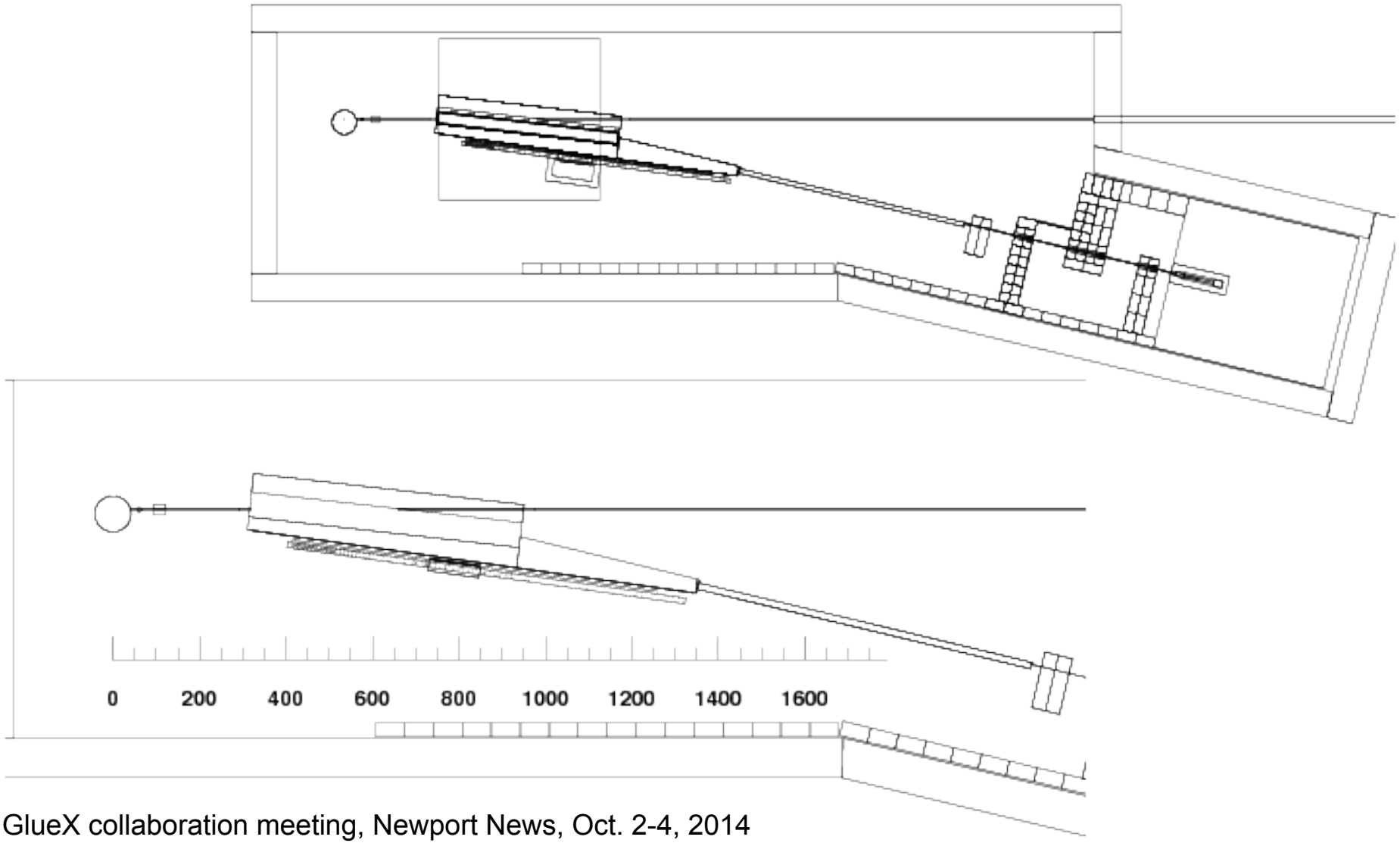
new simulation results

energy deposition in the tagging counters



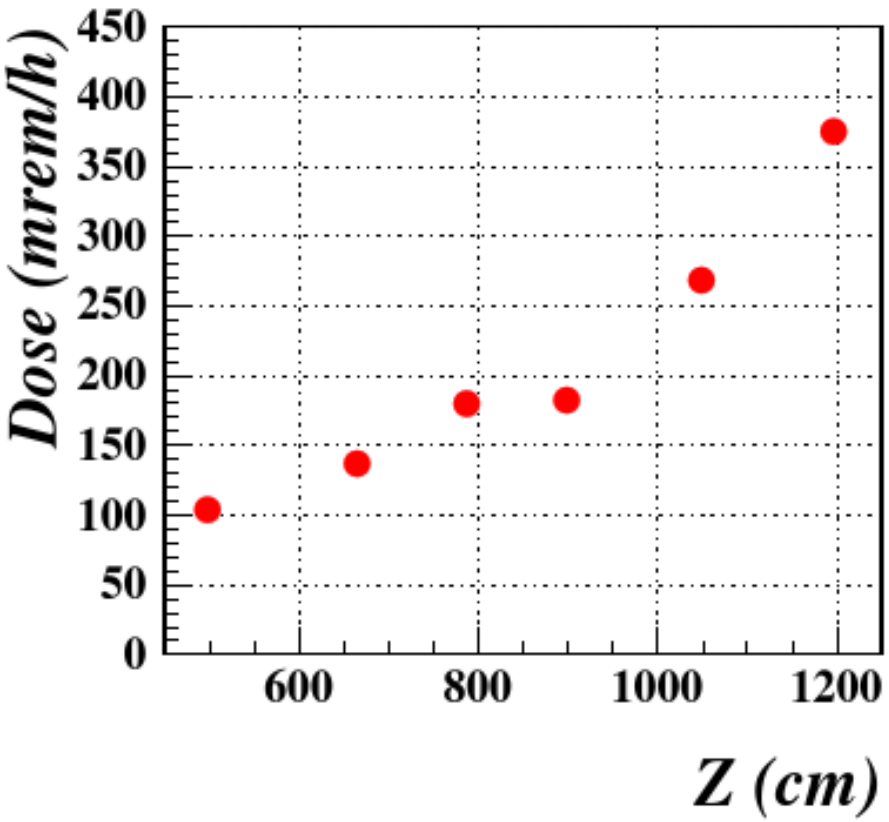


new simulation geometry

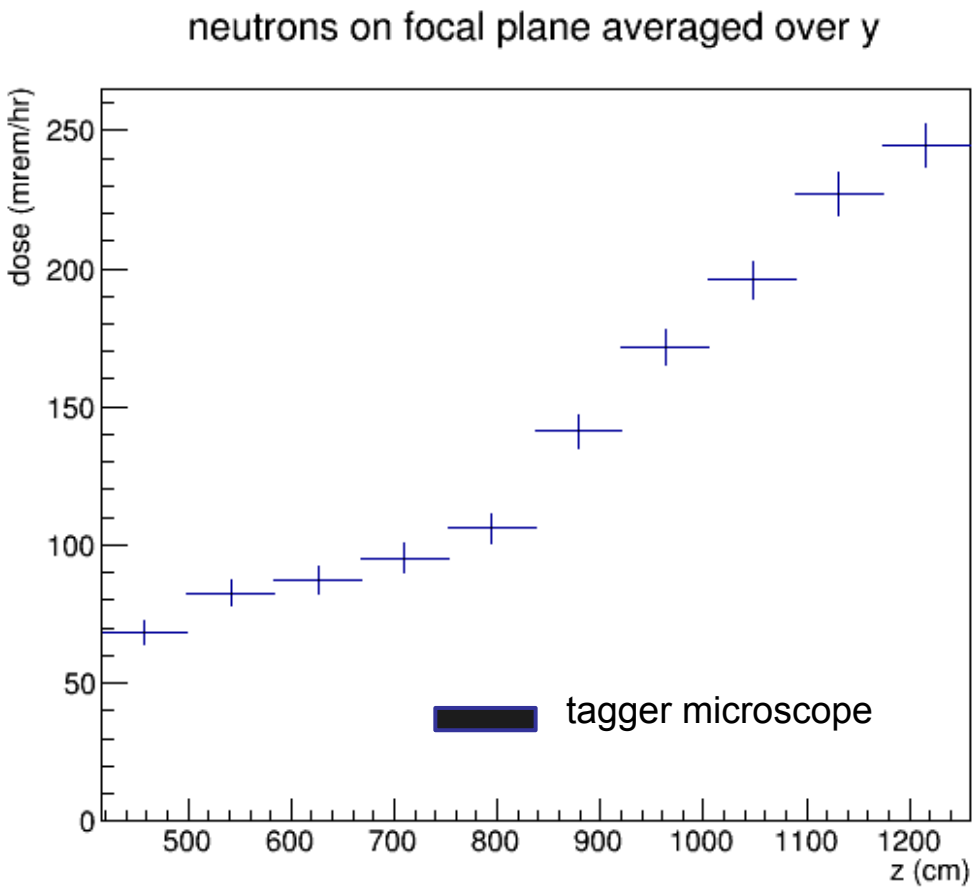


background dose rates:
comparison with gluex-doc-1646

gluex-doc-1646

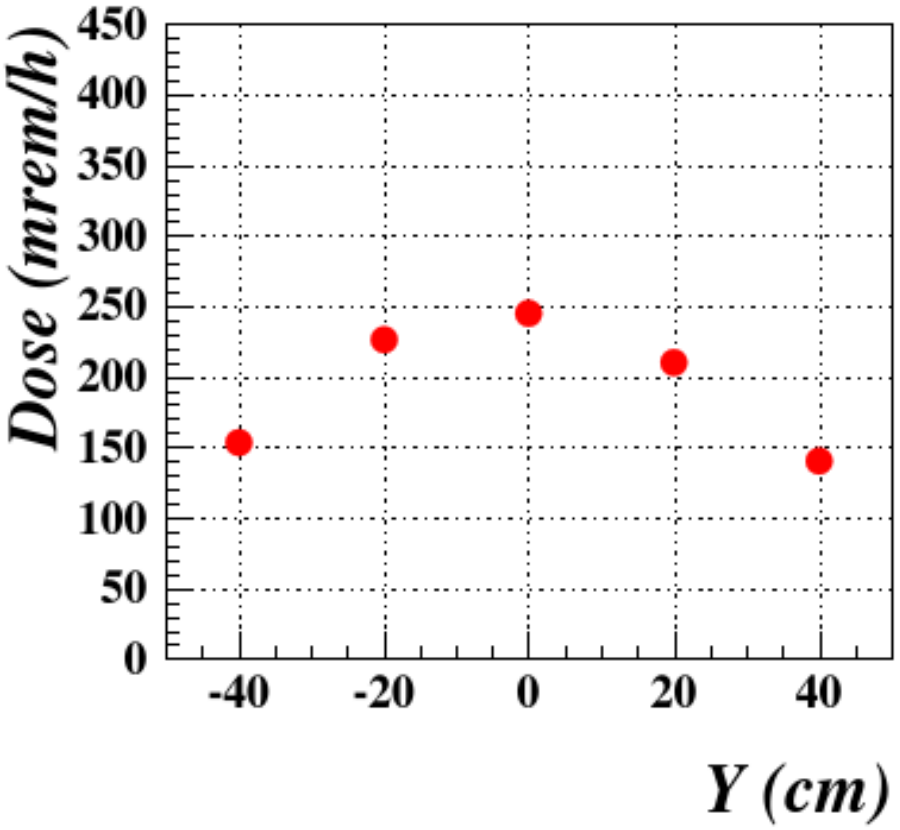


new simulation result



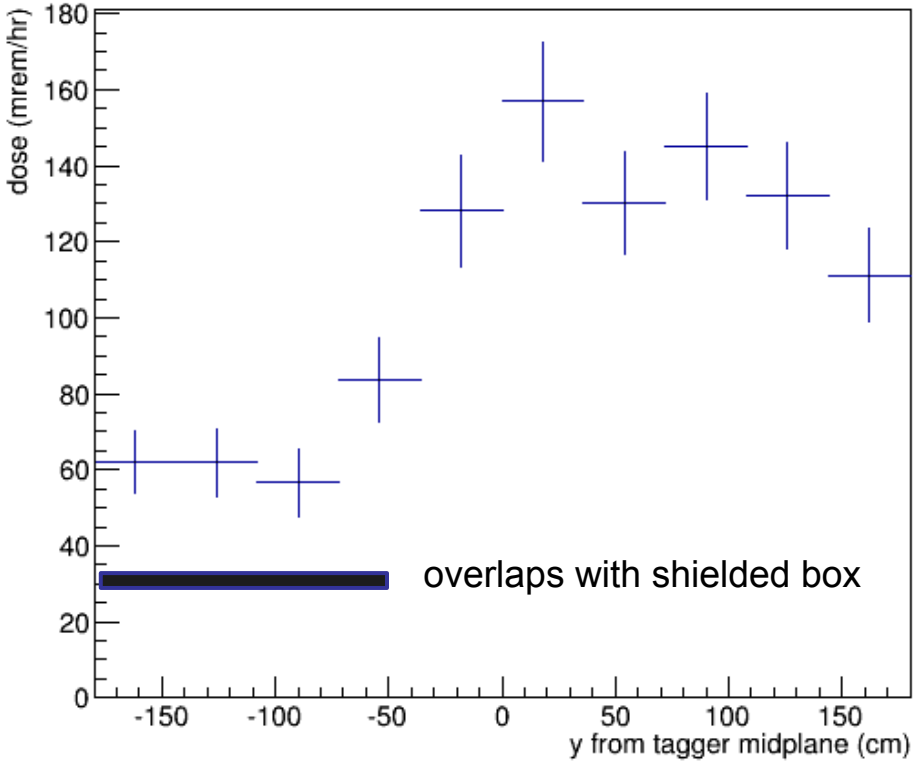
background dose rates:
comparison with gluex-doc-1646

gluex-doc-1646



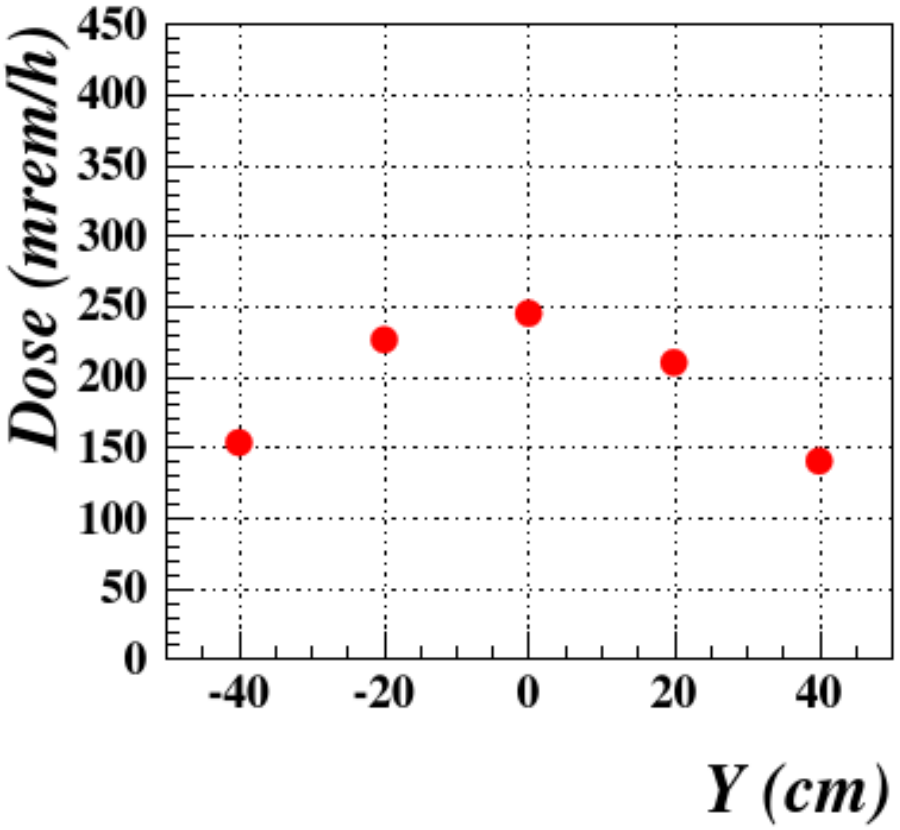
new simulation result

neutrons at position of micoscope

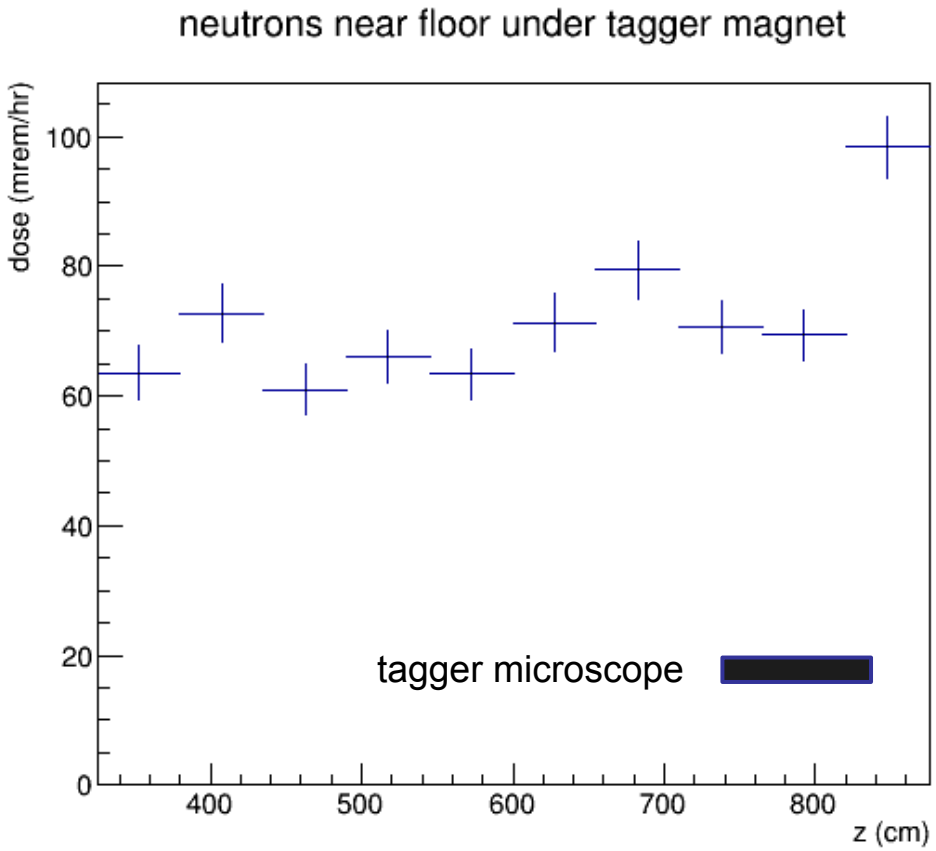


background dose rates:
comparison with gluex-doc-1646

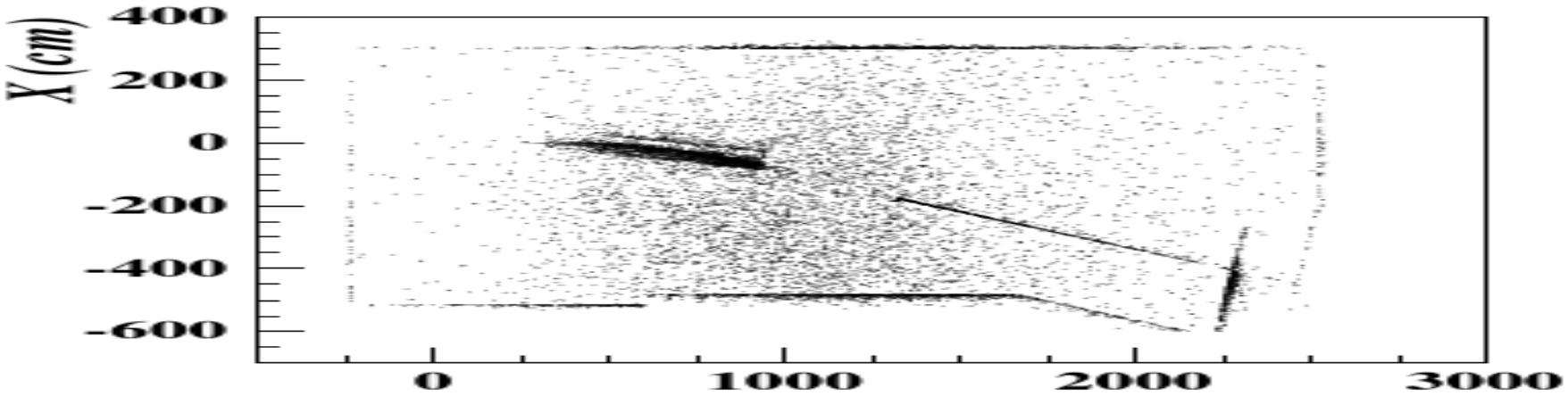
gluex-doc-1646



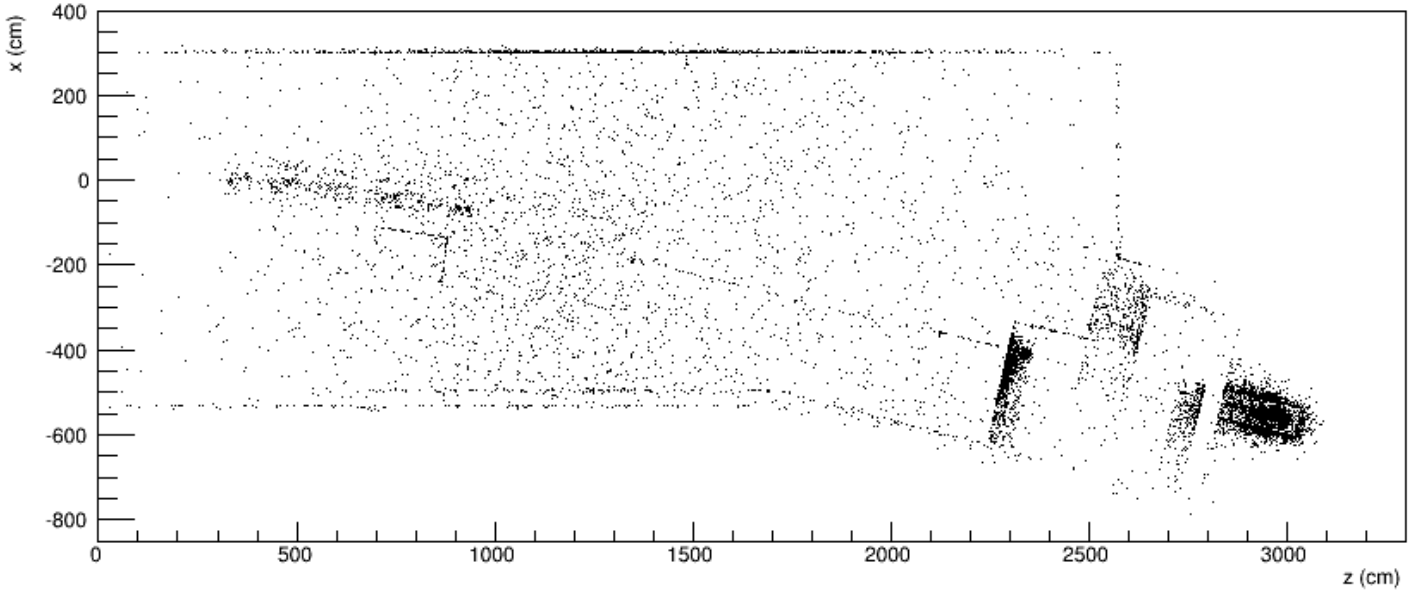
new simuation result



background sources:
comparison with gluex-doc-1646

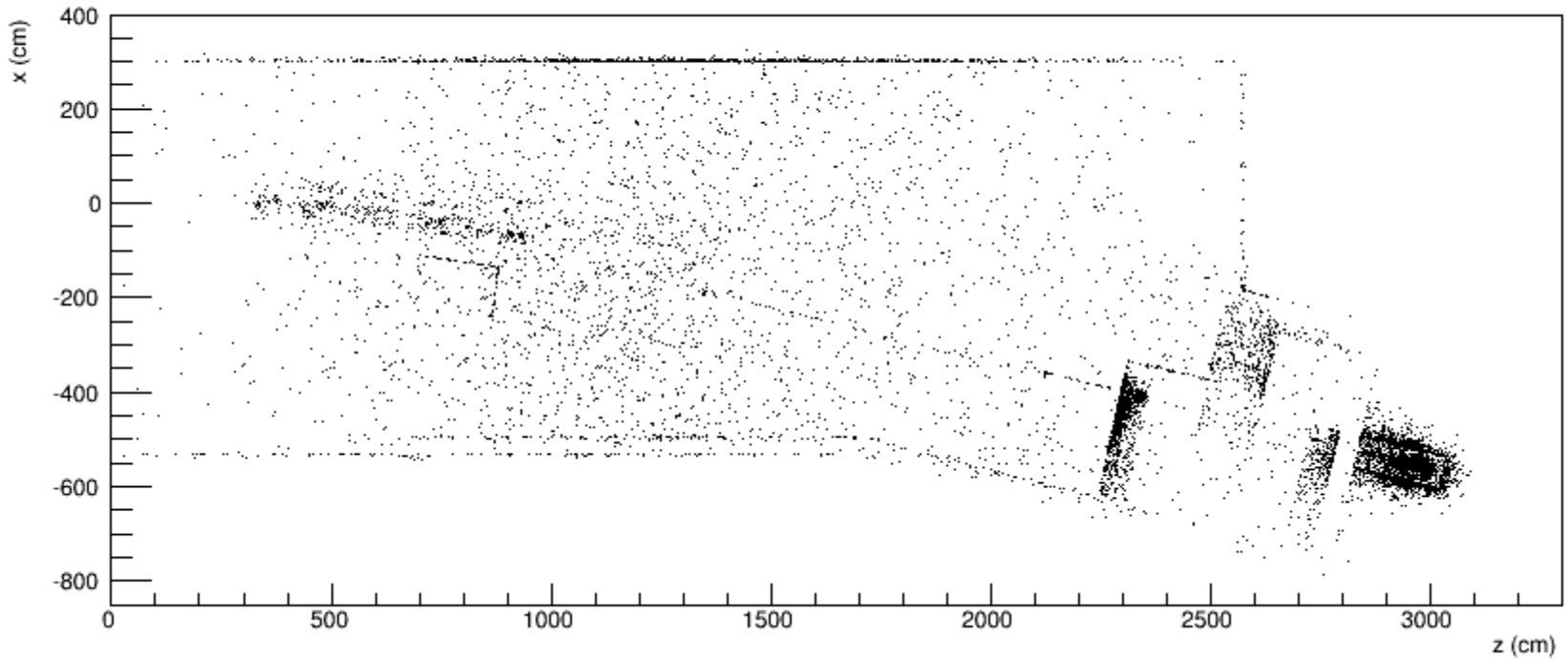


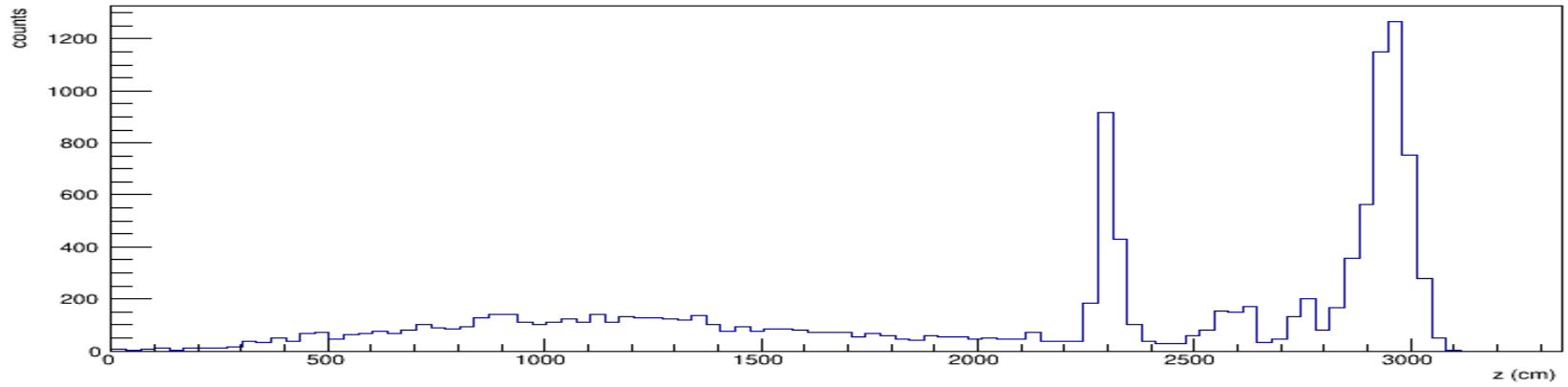
origin of neutrons reaching the focal plane



background sources

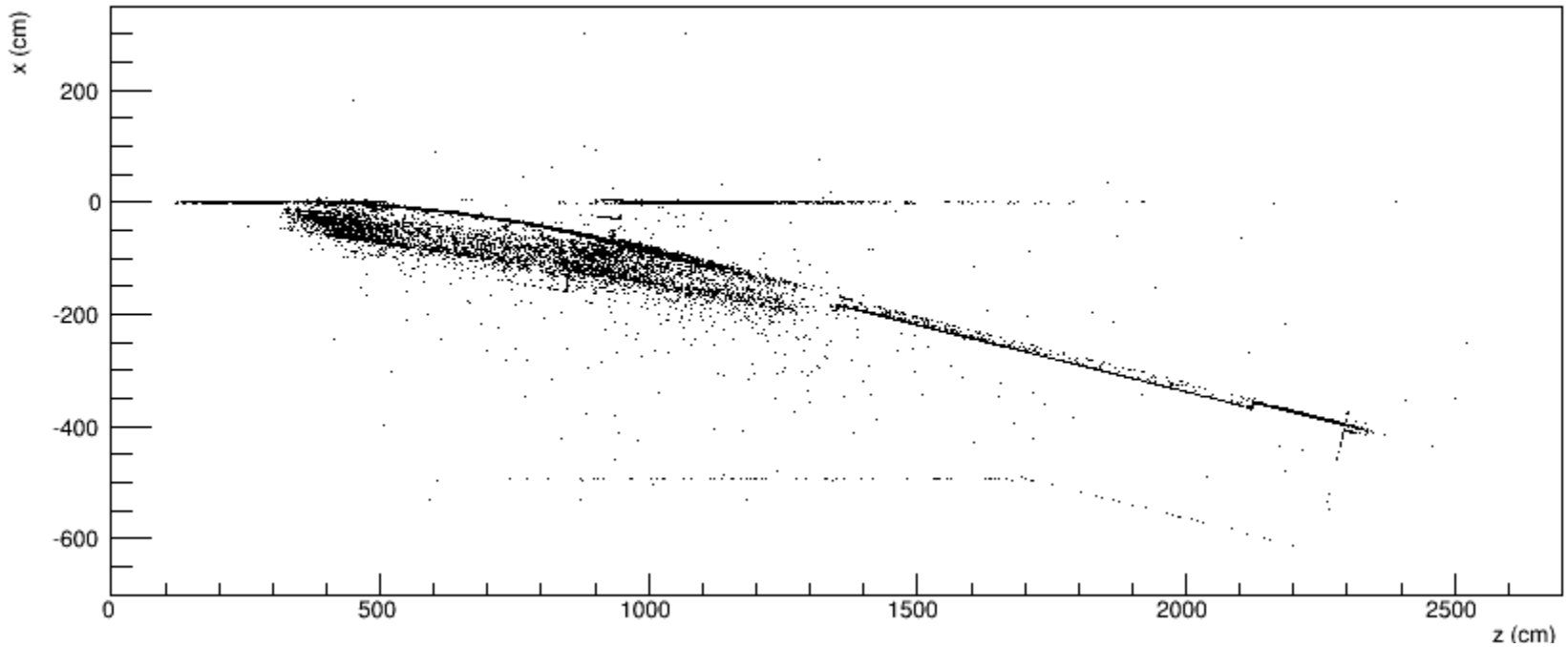
origin of **neutrons** reaching the focal plane

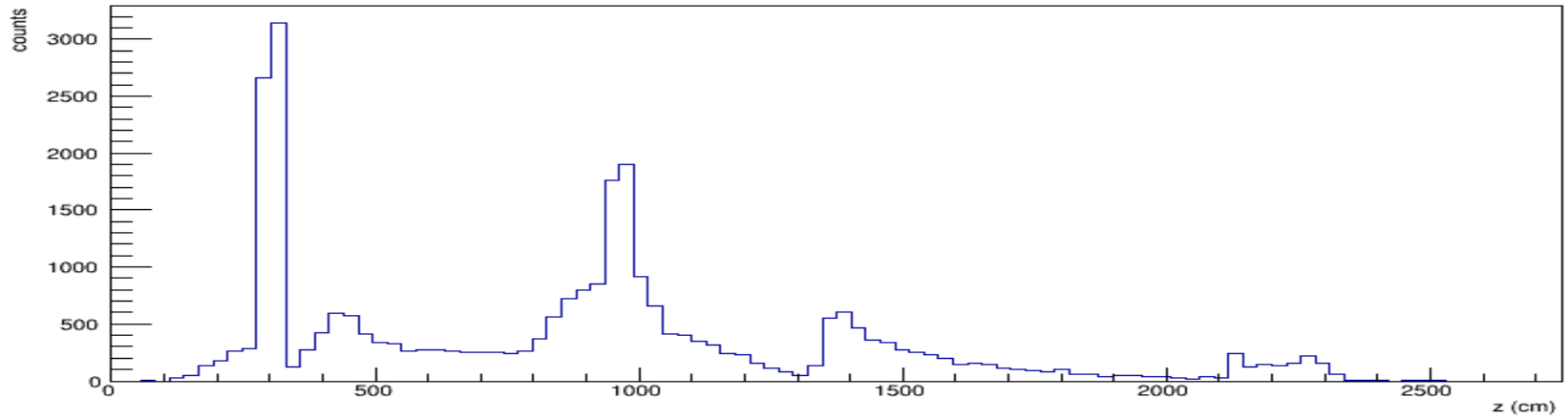




background sources

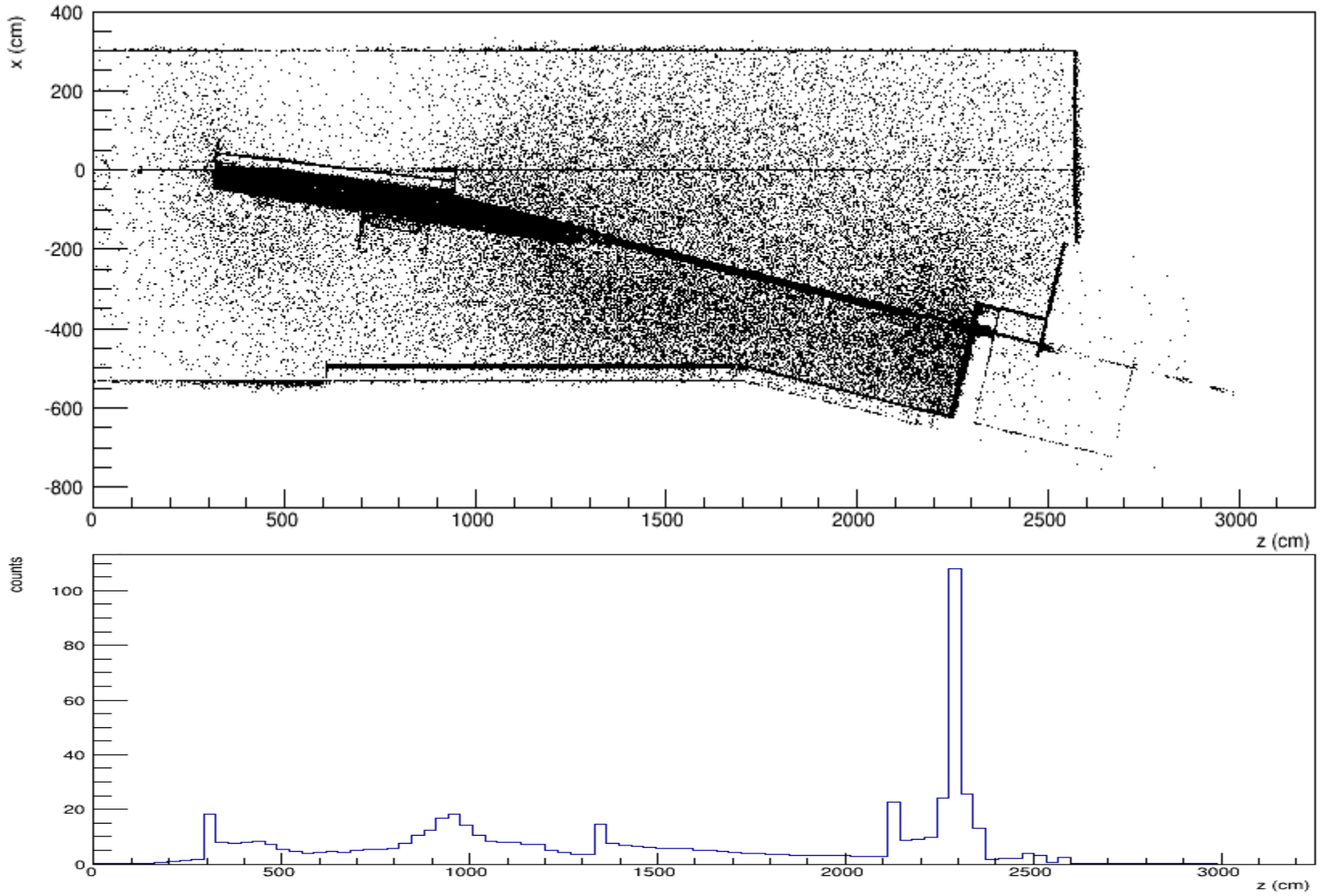
origin of e^+/e^- bg reaching the focal plane





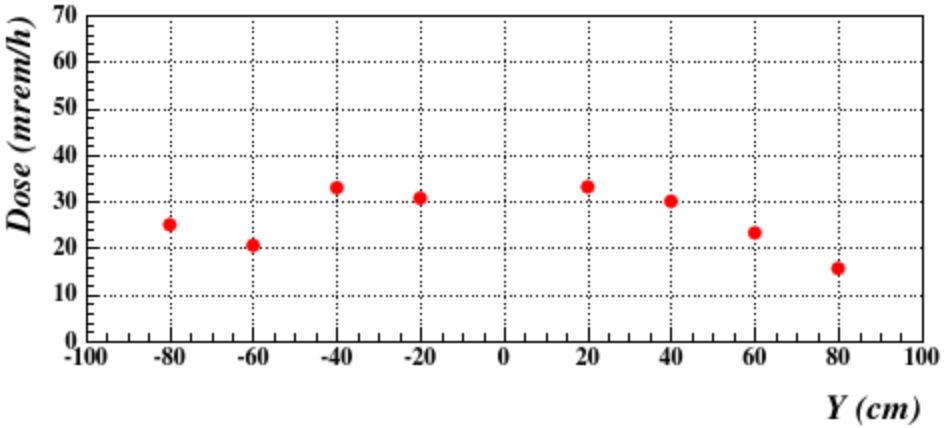
background sources

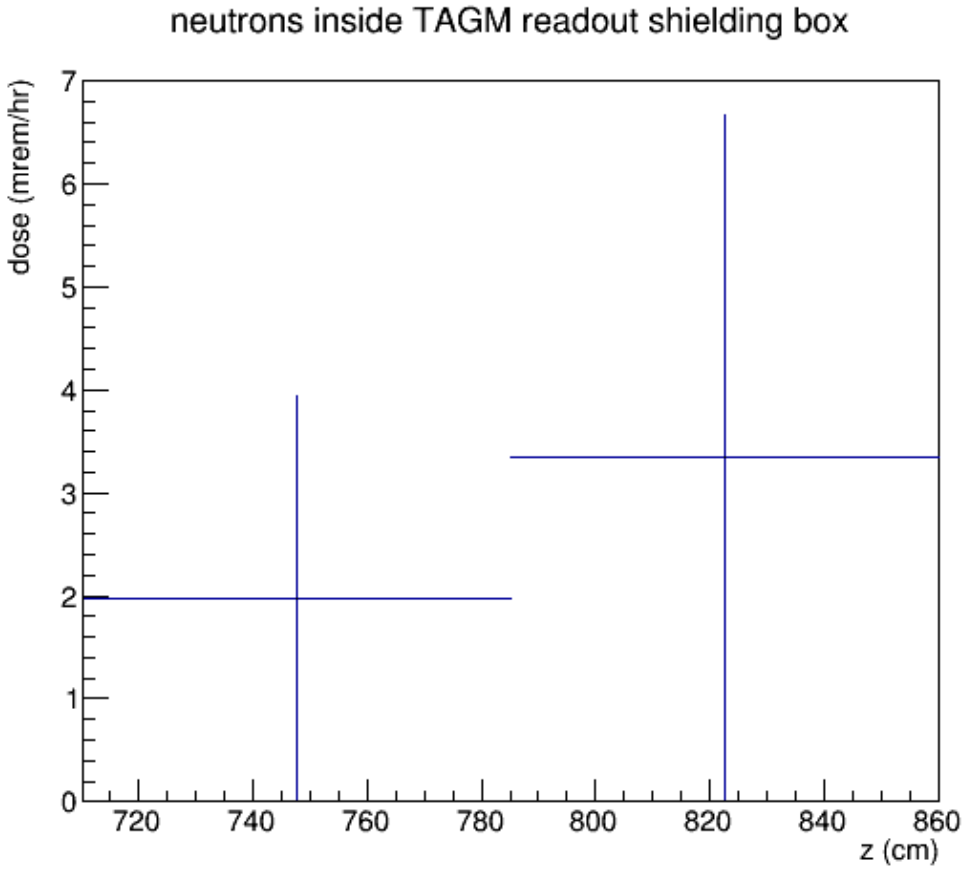
origin of **gammas** reaching the focal plane



background sources

neutron dose rate on TAGM readout electronics



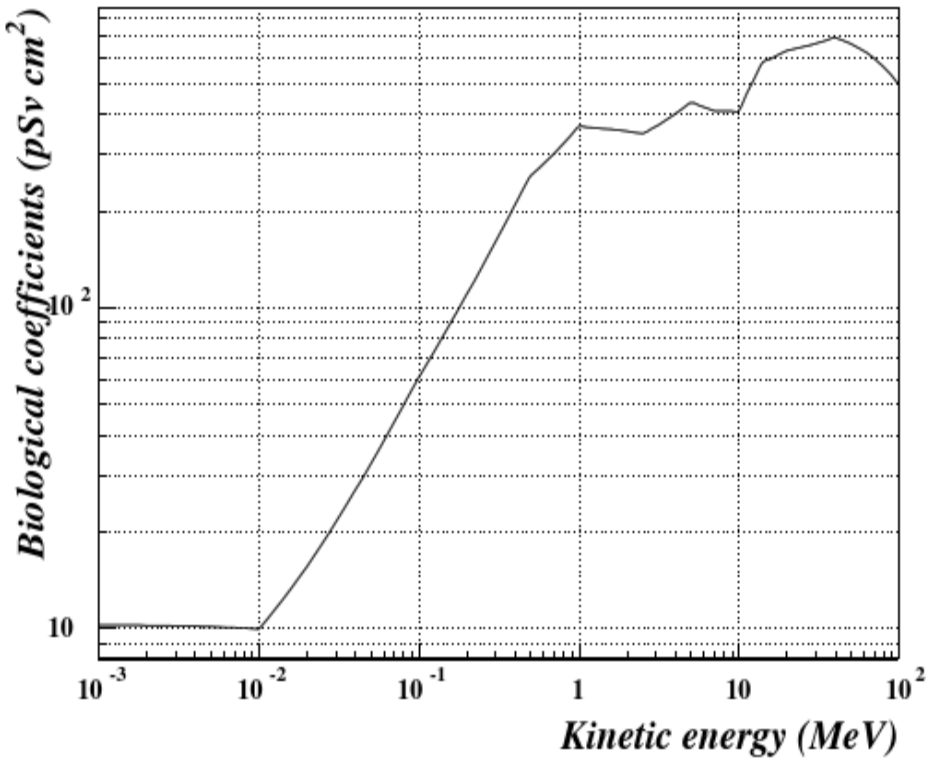


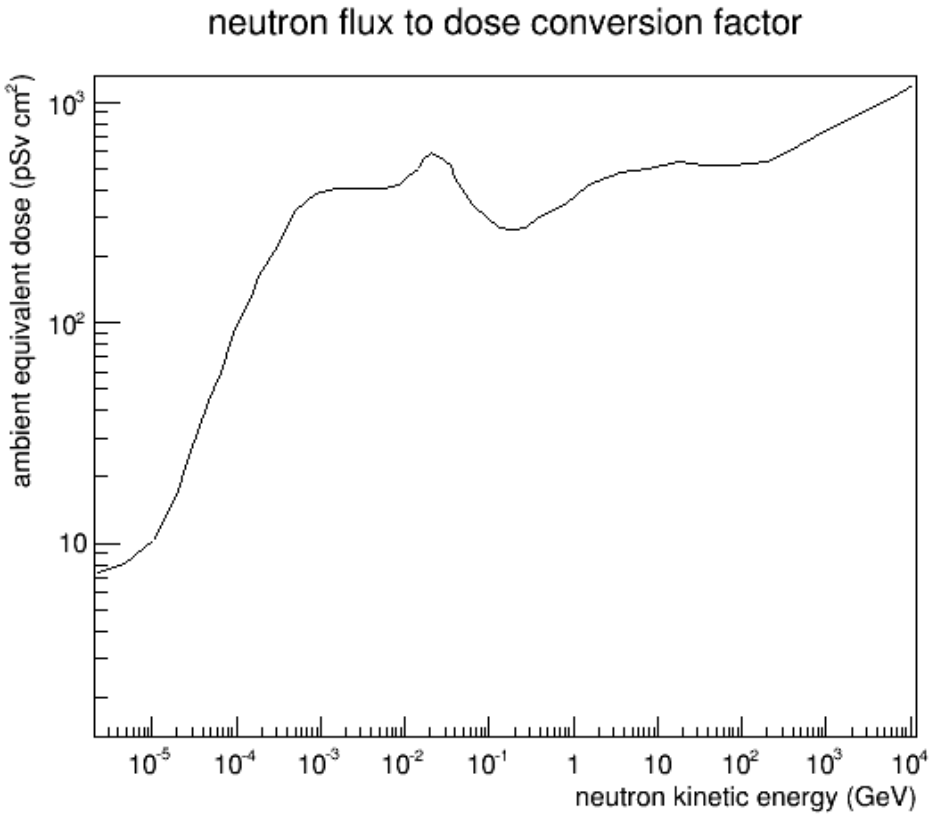
Reduction for new configuration is much larger than the factor ~2 seen elsewhere in the area.

New configuration may be overkill but it works!

background comparison
what has changed with the neutron dose?

Dose is computed using a weight factor that strongly depends on the kinetic energy of the neutron.





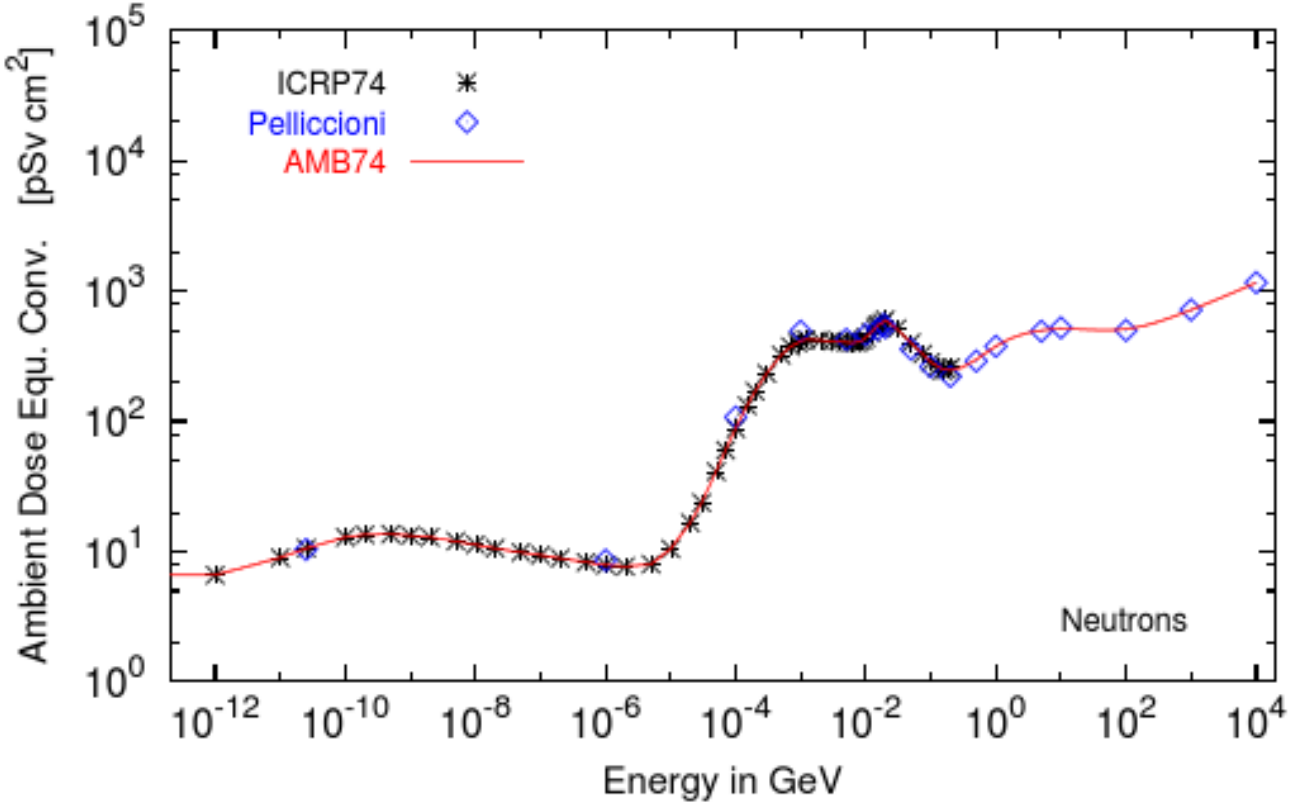
background comparison

what has changed with the neutron dose?

Dose is computed using a weight factor that strongly depends on the kinetic energy of the neutron.

I used **"ambient dose equivalent"** but choice is not unique.

Fig. 2 taken from S. Roesler et.al., CERN-SC-2006-070-RP-TN



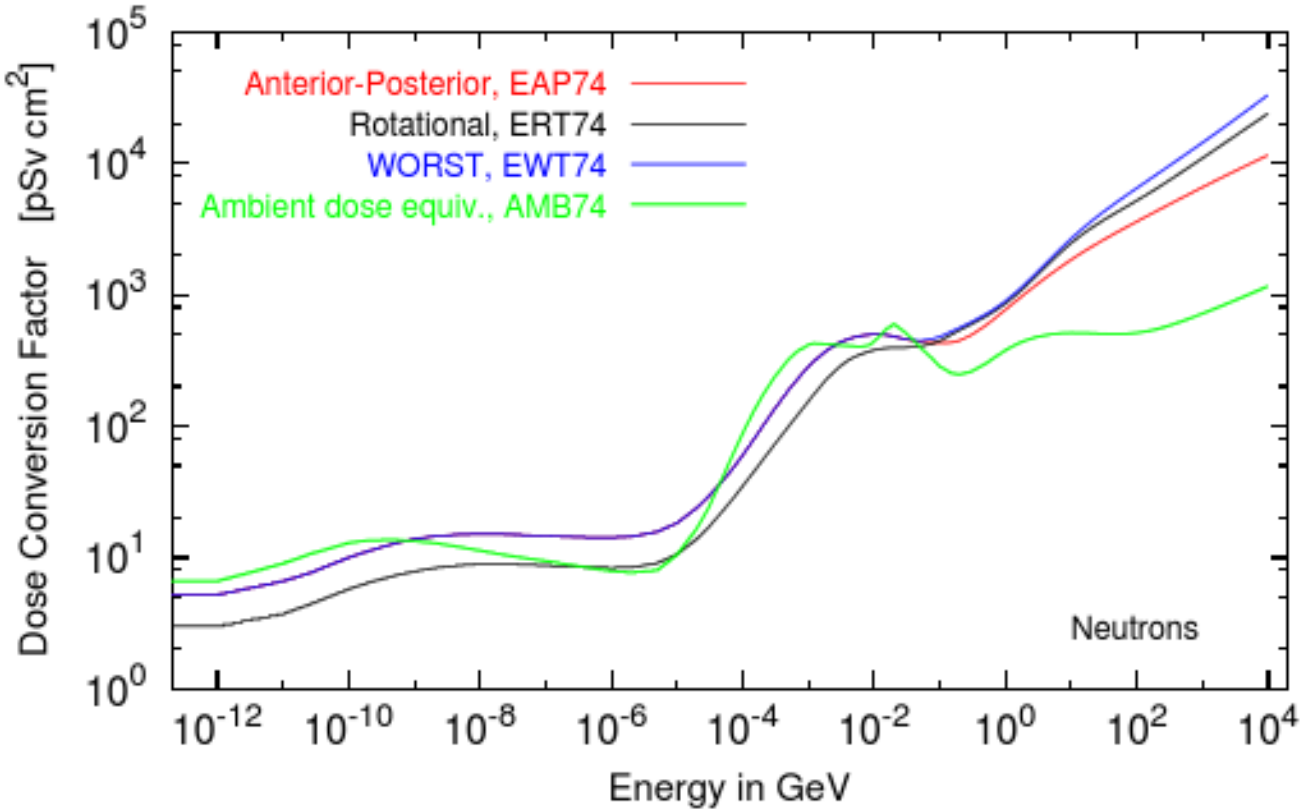
background comparison

what has changed with the neutron dose?

Dose is computed using a weight factor that strongly depends on the kinetic energy of the neutron.

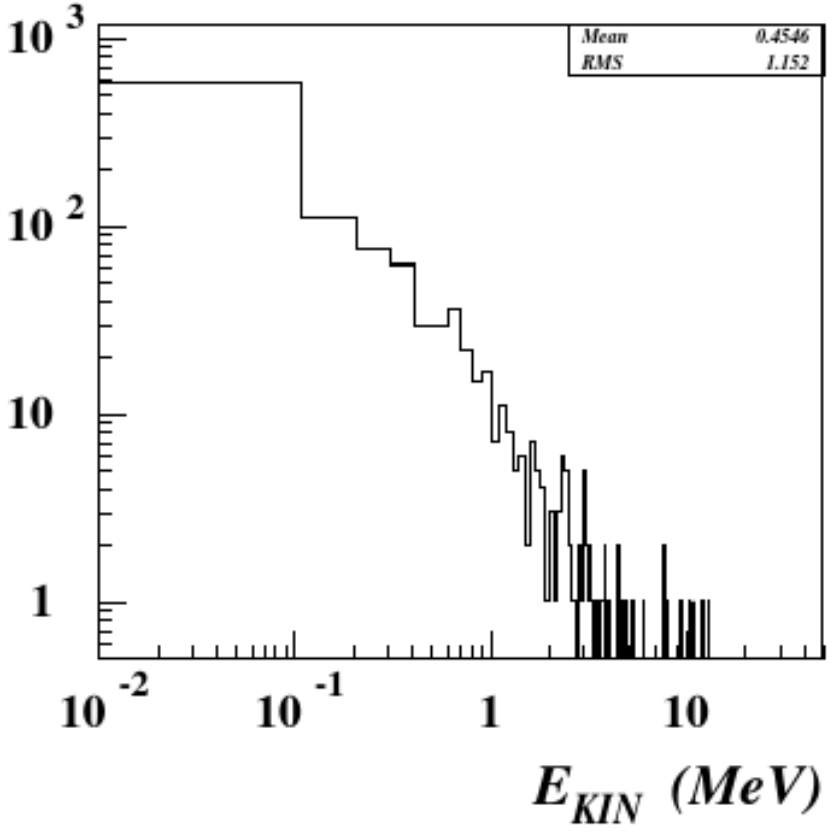
I used **"ambient dose equivalent"** but choice is not unique.

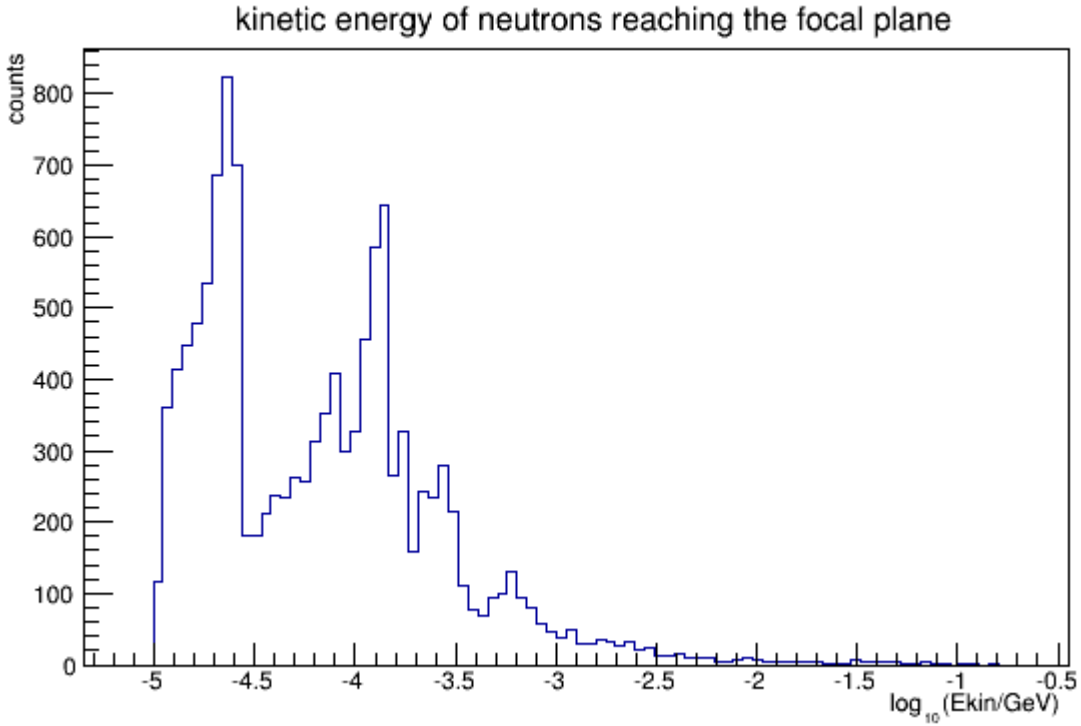
Fig. 2 taken from S. Roesler et.al., CERN-SC-2006-070-RP-TN



background comparison
what has changed with the neutron dose?

Dose is computed using a weight factor that strongly depends on the kinetic energy of the neutron.





remaining issues

- **Nothing catastrophic has appeared due to changes in the beam line geometry.**
- Overall normalization needs to be set by measurement.
- The beam dump is a dominant (~50%) source of all neutrons at the focal plane, so we cannot simulate bg without it.
- Results are insensitive to halo using the current model, **but it is critical to measure the halo during this run both before and after the tagger to check if this is correct.**